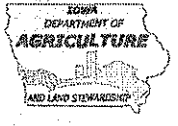
Taking Odor Mitigation to the Next Level: A Priority for Iowa Agriculture

TABLE OF TECHNOLOGIES: Tier 1, Tier 2 and Emerging



IOWA STATE UNIVERSITY
College of Agriculture and Life Sciences

TIER 1 TECHNOLOGIES

Tier 1 Technology	Definition	Application	Key Research Questions
Biofilters for swine farms	Biofilters are devices using media (e.g., wet wood chips) that absorb odors, allowing for microbial action to treat odor-causing compounds. Biofilters have been proven to be effective in mitigating odors, ammonia and hydrogen sulfide at swine facilities.	Exhaust air from swine houses	• Will biofilters be adaptable across many production systems? • What impacts, if any, do biofilters have on animal production and performance? • Are biofilters capable of working with locally available biomass as a way to keep costs down?
Animal diet manipulation	Manipulation of livestock diets may alter excretion composition, and thus odors. Studies have identified trends towards reduced swine odors by feeding less crude protein, for example.	Livestock housing practices	• How does the use of feed ingredients that reduce excess amino acids affect ammonia and odor from manure? • Will further processing of carbohydrate feedstuffs increase digestibility and reduce odors from stored manure? • How can sulfur-containing amino acids in the diet be reduced to obtain reductions of odors from manure?
Vegetative environmental buffers (swine, layers)	Vegetative environmental buffers are linear arrangements of trees and shrubs that have been shown to mitigate odors. Trees and shrubs manipulate air movement, helping to intercept, disperse and/or dilute odors. Research suggests that strategic use of the buffers near livestock and poultry facilities can play an important role in mitigating odor in an economically feasible way.	Exhaust air from swine, layer operations	• What are key buffer design parameters and how can they be managed to enhance particulate filtration and vertical mixing of air while minimizing costs? • What are long-term health impacts on trees exposed to conditions near livestock operations? How do stressors, including ammonia, dust, soil nutrients, desiccation and potential dormancy, affect trees? What species are best suited to such conditions and can provide mitigation? What management practices may enhance tree survival?
Siting model for swine farms	ISU has developed a computer model for helping producers make decisions on where to locate new swine production systems. The Community Assessment Model currently is developed for swine only.	Selection of favorable locations for new swine facilities	• How well did the model perform for farmers who used it to make siting decisions? • Can the number of odor mitigation strategies be expanded to incorporate into the model? • How does terrain impact wind patterns?
Permeable and impermeable manure-storage covers	Permeable covers (e.g., straw, cornstalks, peat moss, foam, Leka rock) act as biofilters on top of manure storage areas. Permeable covers reduce emissions, in part, by reducing both radiation onto the surface and wind velocity. An impermeable cover (e.g, polyethylene) prevents the release of gases and eliminates effects of wind and radiation.	Liquid manure storage areas	• What must be done to more clearly understand initial costs, installation and longevity? • With impermeable covers, what level of effectiveness can be achieved and what issues or complications must be resolved related to pump-out?

TIER 2 TECHNOLOGIES

Tier 2 Technology	Definition	Application	Key Research Questions
Advanced biofilters for swine	Biofilters are devices using media (e.g., wet wood chips) that absorb odorous gases, allowing for microbial action to treat odor-causing compounds. Biofilters have been proven to be very effective in mitigating odors, ammonia and hydrogen sulfide. However, the technology only has been tested on a few swine production facilities. The need exists to demonstrate biofilter performance on a wide variety of facility styles and ventilation systems, especially tunnel-ventilated barns. The technology also requires a relatively large footprint to reduce the back-pressure effect on ventilation fans and to allow ample time for odorous gases to be in contact with the media.	Exhaust air from swine houses	• What are the consequences on animal performance and ventilation fan longevity? • Can biofilters be successful on tunnel-ventilated swine barns? What barn modifications are needed to accommodate biofilters using existing fan systems? • What is the minimum amount of biofiltered ventilation air that yields successful mitigation of odors at mandated separation distances? How can a control system be developed to accommodate this partial mitigation strategy?
Vegetative environmental buffers (dairy, beef)	Vegetative environmental buffers are linear arrangements of trees and shrubs that have been shown to mitigate odors. Trees and shrubs manipulate air movement, helping to intercept, disperse and/or dilute odors. Research suggests that strategic use of the buffers near livestock and poultry facilities can play an important role in mitigating odor in an economically feasible way.	Air from livestock operations	• How do vegetative environmental buffer mitigation dynamics (e.g. turbulent transfer dilution, particulate filtration, wind speed manipulation) vary across animal species, production scale and building/ventilation types? • How do feedlot wind dynamics impact the turbulent transfer (e.g., dilution effects) of feedlot emissions into the lower atmosphere? • What are the key design parameters for particulate filtration specific to feedlot particulate loads?
Biofilters for poultry farms	Biofilters on swine farms have been shown to be an effective means to significantly reduce odor, particulate matter and gas emissions. Biofilters have not been applied to poultry production systems due to foreseeable problems with plugging of the system with feathers. But biofilters may have the potential to control odors from manure storage facilities on poultry operations using manure-belt systems, which frequently remove manure from laying houses.	Exhaust air from manure storage shed of manure-belt laying hen houses; exhaust air of swine houses	• How many months in a year can the biofilter work effectively in reducing odor and gas emissions of manure storage under Iowa weather conditions? (Air in manure storage sheds can be quite cold in winter.) • What type of media, amount and configuration will provide the most effective odor and gas removal? How often will biofilter media need to be changed to maintain efficacy? • What are the capital and operation costs of the biofilter system on a per animal basis? What's the range of odor and/or gas emission reduction?

Wet scrubbers	Wet scrubber technologies use water to remove odors and gas emissions from ventilation air. Some swine and poultry producers in Germany and the Netherlands are using wet scrubbers. A wet scrubber may have a three-stage (dust-ammonia-odor) or two-stage operation. Performance data under field conditions are relatively limited. Wet scrubbers may have good potential for odor control in manure storage in manure-belt egg operations as well as tunnel-ventilated swine barns.	Exhaust air from manure storage sheds of manure-belt laying hen houses; exhaust air of swine houses	• What is the relationship between amount of air flow and odor reduction efficacy for the wet scrubbers, over the short term (e.g., 3 months) and extended term (e.g., 5 years)? • How many months in a year can the wet scrubber work effectively in reducing odor and gas emissions under Iowa weather conditions, especially for manure storage sheds (for manure-belt laying hen houses)? • What is the capital and operation costs of the biofilter system on a per animal basis? What is the range of odor and/or gas emission reduction?
Topical treatments for layer, turkey farms	Extensive lab-scale studies have shown that topical application of certain chemical or mineral agents to poultry manure significantly reduces ammonia and odor emissions. Appreciable reduction may be possible under field conditions. Research must focus on developing an economically viable mechanical delivery system for application of the treatment agents under certain field conditions (e.g., laying hen manure storage with manure-belt system), and systematic evaluation of performance under commercial production conditions.	Manure storage piles of manure-belt laying hen houses	• For each treatment agent, what is the optimal application rate and/or frequency to achieve appreciable reduction (e.g., 70%) in odor and gas emissions? • What is the impact of emission suppression from manure and the fertilizer value of resulting manure? How does the topical application affect odor and gas emissions during cleanout? • What are the capital and operation costs of the topical treatment delivery system and material requirement on a per animal basis? What is the range of odor and/or gas emission reduction?
Biocurtains	Biocurtains reduce odor and gas emissions by taking out dust in exhaust air. Some research under commercial animal production conditions has shown promise, although quantitative data in system performance are lacking. Biocurtains may have potential for odor control in poultry and swine barns by reducing transport of particulate matters beyond the exhaust fans.	Exhaust air of poultry and swine houses	• What are the installation requirements for different types of building ventilation systems, i.e., cross ventilation versus tunnel ventilation? The same is true for different animal species, e,g., poultry (e.g., high-rise layer houses) vs. swine houses. • What is the maintenance requirement, especially in poultry houses where feathers exist, for biocurtains to work properly? What is the efficacy and longevity of the system under adverse (winter) weather conditions? • What are the capital and maintenance costs of the biocurtain system on a per animal basis? What is the range of odor and/or gas emission reduction?
Electrostatic particulate ionization	Electrostatic particulate ionization reduces odor and gas emissions by removing the dust to which odorous compounds adhere. Some research under commercial animal production conditions has shown promise, but also exposed some practical issues. The technology may have the potential for odor control in poultry and swine barns by reducing particulate matter emissions.	Indoor air of poultry houses and swine houses	• What is the optimum in-house placement of electrostatic particulate ionization lines to achieve the most cost-effective reduction of odor and gas emissions? • What is the impact of improved indoor air quality on animal performance? • What are the capital and maintenance costs of the EPI system on a per animal basis? What is the range of odor and/or gas emission reduction?

Siting model developed for all species	ISU has develcped a computer model for helping producers make decisions on where to locate new swine production systems. The Community Assessment Model currently is developed for swine only. A need exists to expand the model to include other animal and poultry production systems in Iowa. The key factor needed in the model for development purposes is odor emission data, which includes odor concentration at the source combined with simultaneous ventilation rates at the source.	Selection of favorable locations for new facilities for all species	• What odor emission rates are to be expected from barn ventilation air and the corresponding outside manure/litter storage units from high-rise layer barns, belt-house layer barns, turkey finishing barns, beef barns and dairy barns as affected by season? • For all cases listed above, what is the odor concentration measured at 0.25 and 0.50 miles downwind, using an olfactometer, simultaneously measured during source odor emission measurements, by season? • Do the predictions in the siting model for a source implementing odor mitigation agree with field-measured downwind odor concentrations?

EMERGING TECHNOLOGIES

Emerging Technology	Definition	Application	Key Research Questions
Ultraviolet treatment	Ultraviolet treatment uses ultraviolet light to break down odorous compounds. Lab research shows that UV light can be effective in removing livestock odors from moving air. The project would use low-wattage ultraviolet lamps to treat exhaust air from swine and layer facilities. The project aims to continue testing and optimizing the technology in the lab and then begin moving it toward pilot-scale and eventually to the field.	Exhaust air from swine, layer operations	• Can odor be controlled in a UV treatment time that is consistent with air turnover rates and environmental conditions (presence of dust and moisture) in exhaust from swine and poultry facilities? • How can UV treatment be optimized for swine and poultry operations through evaluation of effects of wavelength, treatment time and presence of photocatalysts, dust, moisture and other gases, in a sequence of experiments leading from lab scale to pilot scale to commercial scale? • How would costs for commercial-scale UV treatment compare to costs associated with existing odor reduction technologies for swine and poultry facilities?
Solid manure injection	A majority of odor complaints are associated with land application of manure. The injection of liquid manure provides excellent odor control during land application. Development of an injection system for solid manure would provide producers with an additional odor control technology during land application.	Application of manure to crop land	• Does an augur or pneumatic injection system approach work best with drier solids (such as turkey litter) and with wetter solids (such as manure from beef feedlots)? • How does the power requirement compare to a liquid manure injection system? • What level of reduction in odor, ammonia and greenhouse gas emissions can be achieved by injecting solid manure compared to traditional application methods?

Floating oil cover on deep pit	The project will evaluate use of a floating oil cover in a deep pit of a swine-finishing facility to reduce odor and gas emissions. Previous research and experience have shown that covering liquid swine manure with a layer of vegetable oil can substantially reduce air emissions.	Deep-pit swine houses	• What is the relationship between the amount of biodegradable oil coverage (thickness) and odor and gas emission reduction over time and production seasons? What is the impact on animal performance? • What is the impact of oil application on manure fertilizer value? How does the oil cover affect odor and gas emissions during pump-out? • What is the cost on a per animal basis? What is the range of odor and/or gas emission reduction?
Topical treatment delivery system	Development of a mechanical delivery system is needed for topical treatment of air emissions mitigation agents. Lab-scale tests have shown that some commercially available chemical or mineral agents are effective in reducing odors and gases from poultry manure. To extend the application to field situations (e.g., manure storage facility in a manure-belt laying hen operation), a mechanical delivery system is essential.	Manure storage piles of manure-belt laying hen houses	• What are the options (e.g., fixed vs. mobile) for the mechanical delivery system for either liquid or powder treatment agents? • What are operational characteristics of each system, i.e., is it clogging resistant, how long will it last? • Can the system be readily applied or installed in a manure storage facility and/or animal housing system?
Other emerging technologies	To be determined		• To be determined

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